

ment, as described below, use of RF energy at a frequency of 2.45 GHz is described. However, in various other embodiments, other RF frequencies may be used, including, but not limited to, 27.10 MHz. In the various embodiments, the source of the RF energy may vary. Additionally, where the RF frequency varies, the resonant tank circuit will vary accordingly.

[0114] In some embodiments, the RF energy may be produced by a magnetron, producing RF waves at a frequency of 2.45 GHz. In the exemplary embodiment, the die cavity **1608** is formed in a metal block **1602**, which may be any type of steel or another metal appropriately used as a die to form the needle tip. A spring-like assembly **1604**, which may be made from beryllium copper, or any other metal, is included and maintains contact with the tube **1600** as the tube approaches the die cavity **1608**. Although described herein in the exemplary embodiment as being “spring-like”, other methods may be used to maintain the contact of the assembly **1604** with the tube **1600**. The die block **1602**, spring-like assembly **1604** and the tube **1600** together create the inductor of the circuit as illustrated in FIG. 17B. The air gap distance **1606** is the capacitor of the circuit as illustrated in FIG. 17B, and is formed between the tube **1600** and the die cavity **1608**.

[0115] To achieve a resonance of 2.45 GHz in the circuit (i.e., a resonant tank circuit), the appropriate capacitance must be achieved against the inductance. As the inductance is fixed, the capacitance is a function of the distance **1606** between the tube **1600** and the die cavity **1608**. The distance may be different for different realizations of the mechanical configuration.

[0116] In the exemplary embodiment, a magnetron may be used to provide energy at 2.45 GHz into a waveguide. The assembly as described above is in communication with the waveguide such that the assembly is heated by the 2.45 GHz energy (see FIG. 17A).

[0117] As shown in FIG. 16A, as the tube **1600** approaches the die cavity **1608**, the tube **1600** contacts the spring-like assembly **1604** and the distance **1606** decreases. At a distance **1606**, the resonant tank circuit is achieved. As the distance **1606** reaches the necessary capacitance, the plasma arc is formed. After the tip **1610** is exposed to the plasma arc for an appropriate amount of time, the plasma arc melts the tip **1610** of the tube **1600**. At the proper time, e.g., when the metal is at the appropriate temperature to enter the die cavity **1608**, the tip **1610** enters the die cavity **1608**, as shown in FIG. 16B. The tip **1610** remains in the die cavity **1608** for an appropriate time to form the desired tip shape. After the appropriate time passes, the tube **1600** is removed from the die cavity **1608**, and as illustrated in FIG. 16C, the tip **1612** has been formed by the die cavity **1608**. The tube **1600** may then be removed from communication with the waveguide.

[0118] The methods described above may be implemented in various embodiments for manufacture including but not limited to, high volume manufacture, where any number of needles, for example, but not limited to, 1-100,000, for example, needles are manufactured simultaneously. With respect to the embodiments described herein, therefore, although the description discusses a singular tube, die cavity, etc., this is not intended to be limited, rather, be an illustration of one embodiment. Multiples of one or more of the elements discussed may be used in the manufacture of 1 or more needles.

[0119] In some embodiments, for example, the die cavity **1608** may be flush with the inside of the waveguide which is in direct communication with the magnetron. An automated control system, controlled by a feedback loop, may be used to advance the tubes into the waveguide and towards the spring-like assembly **1604** and the die cavity **1608**. In addition, one or more light sensors/optical sensors may be used to detect the plasma arc formation. The one or more light sensors may send a signal to a motion control system to advance the tubes **1600**. In addition, one or more temperature sensors may be used to determine the appropriate time to advance the tube **1600** into the die cavity **1608** and/or to remove the tube **1600** from the die cavity **1608**. Additional sensors may be used to detect motion, temperature, light and/or 2.45 GHz energy. Also, in some embodiments, one or more timers may be used in the feedback loop. Although a magnetron is described with respect to the exemplary embodiments, in some embodiments, another source of 2.45 GHz energy may be used.

[0120] Referring now to FIGS. 18A-18B, in other embodiments, a tube or needle **1800**, made from stainless steel or any other metal, may be connected, either removably or crimped together, to a metal part **1804**, for example, a copper part, to form the inductor. In some embodiments, the metal part **1804** may be crimped to the needle (see FIG. 18A). The distance **1806** or gap between needle **1800** and the metal part **1804**, together with the application of RF at 2.45 GHz, completes a resonant tank circuit and a plasma arc may be formed. This will heat the needle **1800**. As described above, one or more sensors, for example, but not limited to, optical and/or temperature, may be used to provide feedback to a control loop and/or processor, to control the duration of the heating of the metal needle **1800**.

[0121] Referring now to FIG. 18B, the methods described above may be used in various processes and method of manufacture, where controlled heating of a metal or other material surface is desired. For example, a the metal part **1802** could take on any form, and as an example, could be a spring-like assembly as discussed above with respect to FIGS. 16A-16C. The needle **1800** may approach the metal part **1802**, completing the resonant tank circuit. Once a plasma arc is formed, at an appropriate time, for example, as the plasma arc diminishes (again, one or more sensors and/or timers, as discussed above, may be used to determine when the plasma arc forms and diminishes) the needle **1800** may advance towards a contact, which may be a plastic part **1804**, which may be any object or contact made from plastic, including, but not limited to, a bag and/or tube, and the plastic may be any type of plastic, including, but not limited to, PVC, PTFE and/or polyurathane. In some embodiments, the contact may not be plastic. As the arc diminishes, while the needle **1800** is being pushed into the plastic part **1804**, the plastic part **1804** may melt and then cool about the needle **1800**. This process may produce a sterile connection between a plastic part **1804** and a needle **1800**.

[0122] Referring now to FIGS. 19A and 19B, in some embodiments, the catheter and introduction needle assembly may include a relief feature in the needle to reduce the effect of the transition between the needle keep and the catheter tip. As shown in FIG. 19A, the needle **1900**, having a needle hole or opening **1904** includes a catheter **1902** about the needle **1900**. The catheter and needle assembly embodiment is described in more detail above. However, this may provide a discontinuous profile at the transition from the